being well acquainted with the ſpecific difference of each plant, before it ripens its ſeed, it is not a little difficult to diſtinguiſh them one from the other. This ſpecific difference will be beſt furniſhed by the leaves. Thus in the henbane, the leaves of the white are placed upon long footſtalks; thoſe of the black have none, but the lower extremity of the leaf ſurrounds the ſtalk.

XXIX. *The beſt Proportions for* Steam-Engine Cylinders, *of a given Content, conſider'd; by* Francis Blake, *Eſq; F. R. S.*

Read May 23, 1751.

THE fire-engine, or (to term it more properly) the ſteam-engine, for draining of mines, is a maſter-piece of machinery, a very capital contrivance in the works of art, and meriting our attention for further improvements. This is univerſally allowed, as well upon account of the theory it is founded on, as its uſefulneſs in practice. And is it arriv'd then at the laſt degree of perfection, that we appear at a ſtand? I think not. The prodigious veſſel of water to be kept always boiling, when only an inconſiderable part of it is employ'd in the work, ſavours too little of the frugality of nature, which we ought ever to imitate. But waving that now, what I would inquire into here, and endeavour to regulate, is, the cylinder's proportion of the altitude and baſe; which hath not, as I know of, been hitherto noticed.

It is evident, in the firſt place, from a fundamental law of mechanics, that, the content of the cylinder remaining the ſame, the quantity of water diſcharged at each lift will in all caſes be equal, by only changing the diſtance of the center of the piſton from the fulcrum of the balance. You will agree likewiſe (for I ſuppoſe the principles and working-part to want no deſcription) that the exceſs of the pillar of atmoſphere above that of the water is a weight on the piſton, driving it to a depth of five feet, or thereabout, by the preſent conſtruction, within the cavity of the cylinder; acceleratedly till friction and an impediment from the ſteam, which remains in the cylinder even after the jet d'eau, and is increaſed in elaſticity, whilſt its bounds are diminiſh'd, ſhall equal the accelerative force; and that then again the piſton is retarded the reſt of the way. It may be convenient to remark too, that if the rarefaction be ſo complete, that the deſcent would be greater than the conſtruction admits of, the retardation is augmented by a *brachium* of the balance preſſing upon ſprings. But to ſay nothing of friction here, we can, notwithſtanding this diminution of force by the remainder of ſteam within the cavity of the cylinder, demonſtrate the ratio of the velocities, and the times of deſcent of the piſtons, in cylinders of unequal altitudes, to be exactly the ſame, as if the reſiſtance was nothing; whence we ſhall without difficulty arrive at ſome concluſion in this matter.

MN is the working-part of a ſteam-engine cylinder, of the uſual height, equal in diameter to a ſhorter one *mn*; and the rarefaction in both of them being ſuppoſed the ſame, $AQ=aq$, $RQ=rq$, and

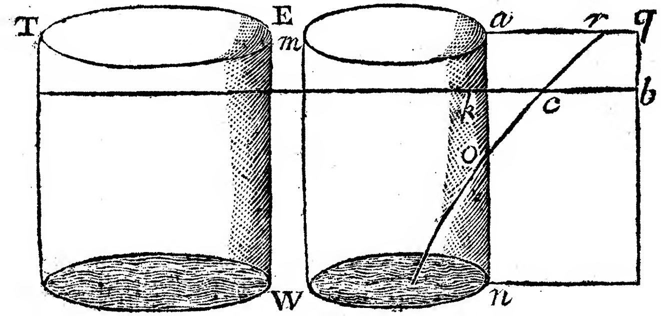
and $AR=ar$, may repreſent the exceſs of the atmoſphere's weight above the pillar of water, the reſiſtance to the piſtons from the remainder of ſteam and the effective force, reſpectively, *e.g.* at the beginning of the deſcent. Take, then, every-where $ak : AK :: an : AN$, and at all ſimilar poſitions the reſiſtance bc of mn and force kc on its piſton will equal the reſiſtance BC of MN and force KC on its piſton; and by what Sir Iſaac Newton has demonſtrated (*Book* 1. *Prop.* 39.) of the deſcent of bodies, we have $\sqrt{akcr} : \sqrt{AKCR}$ :: celerity in k : celerity in K. But theſe areas being evidently as the correſponding parallelograms kq and KQ, and they again as their heights, the celerities generated are in the ſubduplicate ratio of $ak : AK$, as tho' the reſiſtance had been nothing; and by an obvious enough reaſoning from the ſaid propoſition, the times alſo appear to be in the above-mention'd ratio; which ratio is not any way varied, tho' the reſiſtance prevails from the interſecting points O.

Now, to apply what has been ſaid to the buſineſs in hand; if TW be a cylinder of equal content with the cylinder MN, the quantity of water delivered by both will, as a conſequence of the fundamental law of mechanics obſerved above, be the ſame at each lift: but the cylinder TW is no higher than nm, and *ex hypoth.* their rarefactions are equal; and therefore, by what has been proved with regard to the times, the time of the piſton's deſcent in TW will be to that of the piſton's deſcent in $MN :: \sqrt{EW} : \sqrt{AN}$; whence in any given time the broad cylinder TW will perform more than the longer one MN of equal content, and that in the ratio of their diameters;

for $\overline{ET}|^2 \times EW = \overline{MA}|^2 \times AN$, *ex hypoth.* $EW : AN :: \overline{MA}|^2 : \overline{ET}|^2$, and conſequently $\sqrt{EW} : \sqrt{AN} :: MA : ET$. The friction too is diminiſhed with the ſlowneſs of the motion, and becauſe the periphery increaſes in a leſs ratio than does the area of a circle.

The reſult of the whole then is in favour of the broad cylinder; and ſtill the broader the better; for unleſs ſome mechanical conſiderations ſhould limit the problem, 'tis evident in a geometrical ſenſe, that there is no limitation. A diſadvantage might ariſe perhaps to the effect of the jet d'eau from thus increaſing the breadth; which however would be remedied, I think, by a number of theſe jets: but be that as it will, 'tis certain, that to augment the diameters, and diminiſh the lengths of the ſmaller kind of cylinders, now uſed, could have no ſuch inconvenience, nor fail of being attended with an augmentation of force.

What I think might be further obſerved for the improvement of this engine is in the boiler and ſteam, but more connected with experiments; which ſhould I have an opportunity to make, I may reſume perhaps the ſubject, if they anſwer my expectation.



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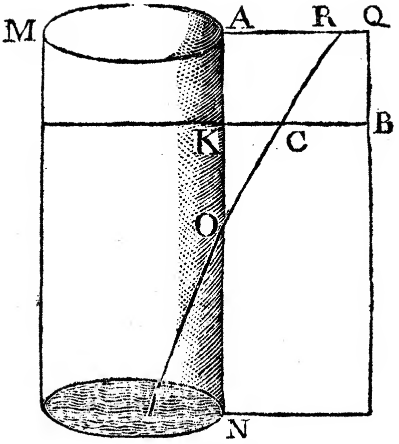

XXX. *Mr.* John Bradley's *Obſervation of the Occultation of* Venus *by the Moon; communicated by Mr.* James Short, *F. R. S.*

Read June 6. 1751.

MR. Gael Morris having favour'd me with the obſervation of the late occultation of Venus by the moon, taken at Greenwich with great exactneſs by Mr John Bradley, I am induced to lay the ſame before the Royal Society, in order to ſhew its very near agreement with thoſe phaſes, which Dr. Bevis obſerved at my houſe in Surry-ſtreet, allowing for the difference of meridians. I muſt take notice, that, beſides the advantage of a ſix-foot reflector with a great magnifying power, which ſhew'd the planet's limb very well defined, he had alſo another, which the doctor had not, I mean

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